CDM-625-IF Advanced Satellite Modem with DoubleTalk® Carrier-in-Carrier®

Satellite Modems

Overview

The CDM-625-IF Advanced Satellite Modem builds on Comtech EF Data's legacy of providing the most efficient satellite modems. It is the first modem to combine advanced Forward Error Correction (FEC) such as VersaFEC® and Low Density Parity Check (LDPC) codes with the revolutionary DoubleTalk® Carrier-in-Carrier® bandwidth compression, allowing for maximum savings under all conditions. This combination of advanced technologies enables multi-dimensional optimization, allowing satellite communications users to:

- Minimize operating expenses (OPEX)
- Maximize throughput without using additional transponder resources
- Maximize availability (margin) without using additional transponder resources
- Minimize capital expenses (CAPEX) by allowing a smaller BUC/HPA and/or antenna
- Or, a combination to meet specific business needs

Features

- DoubleTalk Carrier-in-Carrier bandwidth compression
- Carrier-in-Carrier Automatic Power Control
- Adaptive Coding and Modulation (ACM)
- Packet Processor with header compression, payload compression, advanced Quality of Service (QoS) and Managed Switch Mode
- 4-port managed Ethernet switch with VLAN and QoS
- Jumbo frame support
- 70/140 MHz
- Data Rate: 18 kbps to 25 Mbps
- Symbol Rate: 18 ksps to 12.5 Msps
- Modulation: BPSK, QPSK/OQPSK, 8PSK/8-QAM, 16-QAM
- FEC: Viterbi, Sequential, Concatenated Reed Solomon, TCM, Turbo Product Code (TPC) (IESS-315 Compliant), LDPC Code and VersaFEC (low-latency LDPC)
- Widest Range of data interfaces: EIA-422/530, V.35, G.703 T1, G.703 E1, G.703 T2, G.703 E2, Quad G.703 E1, ASI, LVDS, HSSI, 4-port 10/100Base-T Ethernet
- IEEE 1588v2 Precision Time Protocol
- Sub Mux to multiplex IP/Ethernet traffic with serial or G.703 traffic
- Drop & insert for T1/E1
- Enhanced D&I++ for single T1/E1 & quad E1
- Management: 10/100Base-T Ethernet with SNMP, Distant End SNMP Proxy, HTTP, Telnet and EIA-232/EIA-485
- Carrier ID using MetaCarrier® Technology
- Embedded Distant-end Monitor and Control (EDMAC)
- Automatic Uplink Power Control (AUPC)
- Engineering Service Channel (ESC/ESC++)
- Standard high-stability internal reference ($\pm 6 \times 10^{-8}$)
- 5-tap Adaptive Equalizer
- Open network modes
- 1:1 and 1:10 redundancy switches available

Doubletalk Carrier-In-Carrier

DoubleTalk Carrier-in-Carrier, based on patented "Adaptive Cancellation" technology, allows transmit and receive carriers of a duplex link to share the same transponder space. DoubleTalk Carrier-in-Carrier is complementary to all advances in modem technology, including advanced FEC and modulation techniques. As these technologies approach theoretical limits of power and bandwidth efficiencies, DoubleTalk Carrier-in-Carrier utilizing advanced signal processing techniques provides a new dimension in bandwidth efficiency.

Typical Users

- Mobile Operators
- Telecom Operators
- Satellite Service Providers
- Government & Military
- Enterprise
- Offshore

Common Applications

- Mobile Backhaul
- G.703 Trunking
- IP Trunking
- Offshore & Maritime Communications
- Enterprise
- Communications on-the-Move
- Satellite News Gathering

Figure 1 shows the typical full-duplex satellite link, where the two carriers are adjacent to each other.

Figure 2 shows the typical DoubleTalk Carrier-in-Carrier operation, where the two carriers are overlapping, thus sharing the same spectrum.

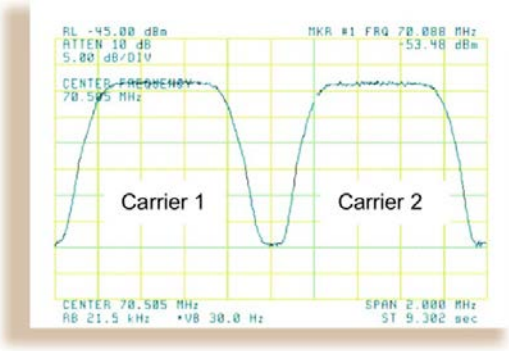

Figure 1

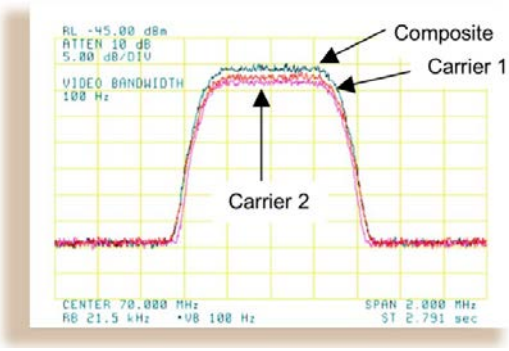

Figure 2

When observed on a spectrum analyzer, only the Composite is visible. Carrier 1 and Carrier 2 are shown in Figure 2 for reference only.

As DoubleTalk Carrier-in-Carrier allows equivalent spectral efficiency using a lower order modulation and/or code rate, it can simultaneously reduce CAPEX by allowing a smaller BUC/HPA and/or antenna. Alternatively, DoubleTalk Carrier-in-Carrier can be used to achieve very high spectral efficiencies E.g., DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8 bps/Hz).

When combined with VersaFEC or LDPC/TPC, it can provide unprecedented savings in transponder bandwidth and power utilization. This allows for its successful deployment in bandwidth-limited and power-limited scenarios, as well as reduction in earth station BUC/HPA power requirements.

Carrier-in-Carrier® is a Registered Trademark of Comtech EF Data
DoubleTalk® is a Registered Trademark of Raytheon Applied Signal Technology
VersaFEC® is a Registered Trademark of Comtech EF Data

Carrier-in-Carrier Automatic Power Control (CnC-APC)

The patent-pending Carrier-in-Carrier Automatic Power Control (CnC-APC) mechanism enables modems on both sides of a CnC link to automatically measure and compensate for rain loss while maintaining the Total Composite Power. In addition to automatically compensating for rain loss, CnC-APC also enables the modems to share link margin, i.e. a modem in clear sky conditions can effectively transfer excess link margin to a distant end modem experiencing fade, thereby further enhancing overall availability.

VersaFEC Forward Error Correction

CDM-625-IF offers VersaFEC, a patented system of high performance short-block low-latency LDPC codes designed to support latency-sensitive applications, such as cellular backhaul over satellite. VersaFEC provides excellent coding gain with lowest possible latency. VersaFEC's Eb/No performance is similar to that of DVB-S2 (short block) or LDPC (16k block) with 70-90% lower latency. Compared to TPC, VersaFEC can provide coding gain of 1.0 dB or more.

The new Ultra Low Latency (ULL) codes provide even lower latency compared to standard VersaFEC codes.

Adaptive Coding & Modulation (ACM)

Satellite users have traditionally relied on worst case link margin to overcome rain fade which leads to significant inefficiencies. ACM converts the fade margin into increased throughput – gain of 100% or more is possible. ACM maximizes throughput under all conditions – rain fade, inclined orbit satellite operation, antenna mis-pointing, noise, interference and other impairments.

ACM can also be used with DoubleTalk Carrier-in-Carrier.

Low Density Parity Check Codes (LDPC) & Turbo Product Codes (TPC)

CDM-625-IF offers an integrated LDPC and 2nd Generation TPC codec. LDPC is an advanced Forward Error Correction technique capable of providing performance much closer to Shannon limit. The current LDPC implementation can provide 0.7 to 1.2 dB additional coding gain compared to an equivalent TPC code.

In order to take full advantage of the increased coding gain provided by LDPC, Comtech EF Data has developed a patented 8-QAM modulation that allows for acquisition and tracking at much lower Eb/No compared to 8PSK.

4-Port Managed Ethernet Switch with VLAN & QoS

CDM-625-IF base modem incorporates a 4-port 10/100Base-T managed Ethernet switch with VLAN capability and priority-based Quality of Service. Access (Native) Mode and Trunk Mode are supported. Traffic can be prioritized using port-based priority or VLAN priority. The maximum Ethernet frame size with Rev 2 HW is 2048 bytes.

Packet Processor

The Packet Processor enables efficient IP networking and transport over satellite by adding routing capability with very low overhead encapsulation, header compression, payload compression and Quality of Service to the CDM-625-IF. The advanced QoS combined with

header and payload compression ensures the highest quality of service with minimal jitter and latency for real-time traffic, priority treatment of mission critical applications and maximum bandwidth efficiency.

Header Compression
The Packet Processor incorporates industry-leading header compression for IP traffic. Header compression can reduce the 40 byte IP/UDP/RTP header to as little as 1 byte. For TCP/IP, the 40 byte header is reduced to as little as 3 bytes. For applications such as VoIP, header compression can provide bandwidth savings exceeding 60%. E.g. the 8 kbps G.729 voice codec requires 24 kbps of IP bandwidth once encapsulated into an IP/UDP/RTP datagram. With header compression, the same voice call needs about 8.5 kbps – a saving of almost 65%. And, bandwidth requirements for typical Web/HTTP traffic can be reduced by 10% or more with TCP/IP header compression.

Payload Compression
The Packet Processor incorporates industry-leading payload compression for IP traffic. Implemented in the hardware for maximum throughput and efficiency, payload compression can reduce the required satellite bandwidth by as much as 40-50%.

Streamline Encapsulation (SLE)
The Packet Processor incorporates Comtech EF Data's patent-pending very low overhead Streamline Encapsulation (SLE). SLE can reduce the encapsulation overhead by as much as 65% compared to industry standard HDLC.

Advanced Quality of Service (QoS)
The Packet Processor incorporates multi-level QoS to ensure the highest quality service with minimal jitter and latency for real-time traffic, priority treatment of mission critical applications and maximum bandwidth efficiency.

Supported modes are:

- DiffServ – Industry-standard method of providing QoS enabling seamless co-existence in networks that implement DiffServ
- Max/Priority – Provides multi-level traffic prioritization with the ability to limit maximum traffic per priority class
- Min/Max – Provides a Committed Information Rate (CIR) to each user defined class of traffic with the ability to allow a higher burstable rate depending on availability

Managed Switch Mode
Managed switch modem enables layer 2 operation with the Packet Processor. This provides significant bandwidth savings for layer 2 operation with very low overhead Streamline Encapsulation, header compression and payload compression.

Quad E1 Interface (QDI) with Enhanced D&I++

The CDM-625-IF supports a Quad E1 interface that can aggregate up to four full or fractional E1s into a single carrier, with very low overhead. This provides significant CAPEX savings by reducing the number of modems and could possibly reduce the BUC/HPA size by eliminating the multi-carrier backoff. A proprietary, closed network drop & insert (D&I++) allows for dropping or inserting any combination of 1 to 31 time slots on each E1. D&I++ is supported for E1-CCS only.

IP Sub Multiplexer

The IP sub mux allows multiplexing IP/Ethernet traffic with serial or G.703 traffic into a single carrier. This is particularly useful for cellular backhaul when both E1 and IP backhaul is required. This reduces the number of modems and could possibly reduce the BUC/HPA size by eliminating the multi-carrier backoff. The IP sub mux ratio ranges from 9:1 (IP data rate is 9 times that of the serial or G.703 data rate) to as low as 1:59.

EDMAC & AUPC

The CDM-625-IF supports EDMAC, EDMAC-2, EDMAC-3 and AUPC. EDMAC/EDMAC-2/EDMAC-3 can be used to monitor and control the distant end of a satellite link using a proprietary overhead channel. EDMAC-3 is also used for SNMP management of the distant end modem. AUPC enables automatic uplink power control for a duplex link.

Management & SNMP Proxy

The modem can be managed via the front panel, the remote M&C port (EIA-232/EIA-485), or the 10/100Base-T Ethernet port. With support for SNMP, HTTP and Telnet, the modem can be easily integrated into an IP-based management system.

The CDM-625-IF can also act as SNMP proxy for the distant end modem. This allows distant end modem management using SNMP without requiring an end-to-end IP link.

IEEE 1588v2 Precision Time Protocol (PTP)

PTP has emerged as the key technology for frequency, time and phase synchronization over a packet network. The CDM-625-IF is the first satellite modem to incorporate hardware support for PTP, thereby significantly improving synchronization accuracy for satellite backhaul. PTP requires Revision 2 modem hardware without the Packet Processor.

Advanced FSK for LPOD Monitoring & Control

The Advanced FSK allows for monitoring and control of LPOD through modem front panel menus, serial remote control and Telnet.

Feature Enhancements

Enhancing the capability of the CDM-625-IF in the field is easy. Features that do not require additional hardware can be added on site, using FAST access codes purchased from Comtech EF Data.

Specifications

Data Rate	18 kbps to 25 Mbps, in 1 bps steps (modulation, FEC & data interface dependant)
Symbol Rate	18 ksps to 12.5 Msps
Operating Frequency	50 – 180 MHz 100 Hz resolution, independent TX and RX operation
Major Operating Modes (See User Manual For Details)	Open network, per IESS-308 / 309 / 310 / 314 transparent, closed network per IESS-315 LDPC / TPC Codec (optional plug-in module) VersaFEC Codec (optional plug-in module) with ACM or Constant Coding & Modulation (CCM) EDMAC Framed with/without AUPC RS Outer Codec High rate ESC / Enhanced ESC (ESC++) Drop & insert (D&I) /Enhanced D&I++ Quad E1 drop & insert (QDI) DoubleTalk Carrier-in-Carrier (optional plug-in module)
FEC Options	
None	Uncoded BPSK/QPSK/OQPSK
Viterbi: k=7, per IESS-308/309	Rate 1/2 BPSK/QPSK/OQPSK Rate 3/4 QPSK/OQPSK Rate 7/8 QPSK/OQPSK
Viterbi with Reed Solomon	Rate 3/4 16-QAM Rate 7/8 16-QAM
Sequential	See user manual for details
Reed Solomon	Open network and closed network modes
TCM (Per IESS-310)	8PSK/TCM Rate 2/3
Integrated LDPC and TPC (2nd Gen) Codec (Optional Plug-in Module)	LDPC Code Rates Rate 1/2 BPSK/QPSK/OQPSK Rate 2/3 QPSK/OQPSK/8PSK/8-QAM Rate 3/4 QPSK/OQPSK/8PSK/8-QAM/16-QAM TPC Code Rates Rate 5/16 BPSK Rate 21/44 BPSK/QPSK/OQPSK Rate 3/4 QPSK/OQPSK/8PSK/8-QAM/16-QAM Rate 7/8 QPSK/OQPSK/8PSK/8-QAM/16-QAM Rate 0.95 QPSK/OQPSK/8PSK/8-QAM
VersaFEC Codec (Optional Plug-in Module)	BPSK Rate 0.488 QPSK Rate 0.533, 0.631, 0.706, 0.803 8-QAM Rate 0.576 (ECCM), 0.642, 0.711, 0.780 16-QAM Rate 0.644 (ECCM), 0.731, 0.780, 0.829, 0.853 BPSK 0.493 (ULL) QPSK 0.493, 0.654, 0.734 (ULL)
Scrambling	IDR Mode, no RS, - per ITU V.35 (Intelsat variant) IBS mode, no RS - per IESS-309, externally frame synchronized Transparent Closed Network mode, no RS or Turbo coding - per ITU V.35 (Intelsat variant) EDMAC mode, no RS coding - externally frame synchronized - proprietary Turbo Product Code/LDPC/VersaFEC modes - externally frame synchronized - proprietary All RS modes - externally frame synchronized per IESS-308/309/310
Management	10/100Base-T Ethernet with SNMP, HTTP and Telnet support, EIA-232, EIA-485 (2- or 4-wire)
Form C Relays	Hardware fault, RX and TX traffic alarms, open network backward alarms
External Reference (Input OR Output)	BNC connector Input: 1, 2, 5, or 10 MHz, -6 dBm to +10 dBm, 50 Ω/75 Ω (nominal) Output: 10 MHz, 2.7 V peak-to-peak ± 0.4 V, low impedance output

Data Interfaces

EIA-422/-530 DCE , Up to 14 Mbps	25-pin D-sub (female)
V.35 DCE , Up to 14 Mbps	
LVDS Serial , Up to 25 Mbps	25-pin D-sub (female)
HSSI Serial , Up to 25 Mbps	
G.703 T1, 1.544 Mbps (Balanced 100 Ω)	
G.703 T2, 6.312 Mbps (Unbalanced 75 Ω or balanced 110 Ω)	9-pin D-sub (female) or BNC (female)
G.703 E1, 2.048 Mbps (Unbalanced 75 Ω or balanced 120 Ω)	
G.703 E2, 8.448 Mbps (Unbalanced 75 Ω)	
ASI , Up to 25 Mbps	BNC (female)
Additional 2.048 Mbps E1 Ports for Quad-E1 (Balanced 120 Ω)	9-pin D-sub (female)
Overhead Data	44-pin High-density D-sub (male)
Modem Alarms	15-pin D-sub (male)
4-port 10/100Base-T Managed Ethernet Switch (Optional Packet Processor Available)	4 x RJ-45

Modulator

Frequency Stability	± 0.06 ppm (± 6 x 10^{-8}), 0° to 50°C (32° to 122°F) with internal reference
Transmit Filtering	Per IESS-308
Transmit Filter Rolloff	25%, 35%
Harmonics and Spurious	Better than -60 dBc/4 kHz (typically <-65 dBc/4kHz) Measured from 1 to 500 MHz
Transmit On/Off Ratio	-60 dBc minimum
Output Phase Noise	< 0.480° rms double sided, 100 Hz to 1 MHz (Minimum 16 dB better overall than the Intelsat IESS-308/309 requirements) dB/Hz Frequency Offset -63.0 100 Hz -73.0 1 kHz -83.0 10 kHz -93.0 100 kHz Fundamental AC line spurious is -42 dBc or lower The sum of all other single sideband spurious, from 0 to 0.75 x symbol rate, is -48 dBc or lower
Output Power	0 to -25 dBm, 0.1 dB steps
Power Accuracy	± 0.5 dB over frequency, data rate, modulation type and temperature range of 15 to 35° C ± 0.8 dB over frequency, data rate, modulation type and temperature range of 0 to 50° C
Output Impedance & Return Loss	50 Ω/75 Ω, 16 dB minimum return loss (18 dB typical), BNC connector
Clocking Options	Internal, ± 0.06 ppm (SCT) External, locking over a ± 100 ppm range (TT) Loop timing (RX satellite clock) – supports asymmetric operation External clock
External TX Carrier Off	By TTL 'low' signal or external contact closure

Demodulator

Input Power Range, Desired Carrier	-105 + 10 log (symbol rate) to -70 + 10 log (symbol rate) dBm
Max Composite Operating Level	94 – 10 log (symbol rate, desired carrier) dBc, +10 dBm max., with the additional requirement that within ± 10 MHz of the desired carrier the composite power is ≤ +30 dBc
Absolute Maximum	+20 dBm
Adaptive Equalizer	5-tap design, selectable on/off
Acquisition Range	Programmable in 1kHz increments
Below 64 ksymbols/sec	± 1 kHz to ± (Rs/2) kHz, where Rs = symbol rate in ksymbols/sec
Between 64 and 389 ksymbols/sec	± 1 kHz to ± 32 kHz
Above 389 ksymbols/sec	± 1 kHz to ± (0.1 * Rs) kHz, up to a maximum of ± 200 kHz
Acquisition Time	Highly dependent on data rate, FEC rate, and demodulator acquisition range. E.g.: 120 ms average at 64 kbps, R1/2 QPSK, ± 10 kHz acquisition sweep range,

	6 dB Eb/No
Plesiochronous/ Doppler Buffer	Selectable from 64 to 262,144 bits, in 16-bit steps (Additional limitations for G.704 frame boundaries)
Receive Clock	RX satellite, TX terrestrial, external reference
Clock Tracking	± 100 ppm minimum
Monitor Functions	E_b/N_0 estimate, corrected BER, frequency offset, buffer fill state, receive signal level

DoubleTalk Carrier-in-Carrier

Delay Range	0 to 330 ms
Power Spectral Density Ratio (Interferer to Desired)	BSPK/QPSK/8PSK/8-QAM: –7 dB to +11 dB 16-QAM: -7 dB to +7 dB
Maximum Symbol Rate Ratio	3:1 (TX:RX or RX:TX)
Eb/No Degradation	0 dB Power Spectral Density Ratio BPSK/QPSK/OQPSK: 0.3 dB 8-QAM: 0.4 dB 8PSK: 0.5 dB 16-QAM: 0.6 dB +10 dB power spectral density ratio Additional 0.3 dB
Satellite Restrictions	Satellite in “loop-back” mode (i.e., the transmit station can receive itself) “Non-processing” satellite (i.e., does not demodulate or remodulate the signal)

Available Options

Hardware	100 – 240 VAC, 175 W AC primary power supply
Hardware	-48 VDC, 125 W primary power supply
Hardware	-24 VDC, 120 W primary power supply
Hardware	Integrated TPC (2nd generation) and LDPC Codec module
Hardware	DoubleTalk Carrier-in-Carrier module
Hardware	VersaFEC Codec module
Hardware	Packet Processor
FAST	Modem data rate – 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	8PSK and 8-QAM modulation (8-QAM requires TPC/LDPC or VersaFEC Codec)
FAST	16-QAM modulation
FAST	TPC/LDPC Codec data rate – 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	DoubleTalk Carrier-in-Carrier (full) – 512 kbps, 1.1 Mbps, 2.5 Mbps, 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	DoubleTalk Carrier-in-Carrier (fractional) – 2.5 Mbps, 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	VersaFEC Codec data rate (CCM) – 2.5 Mbps, 5 Mbps or 16 Mbps
FAST	VersaFEC Codec symbol rate (ACM) – 300 ksps, 1.2 Msps or 4.1 Msps
FAST	Open network – IBS with high rate IBS ESC, IDR and audio
FAST	D&I / D&I++ for single Port T1/E1
FAST	D&I++ For Quad E1 Port 2, 3 and 4
FAST	Quality of Service (requires Packet Processor)
FAST	Header Compression (requires Packet Processor)
FAST	Payload Compression (requires Packet processor)
FAST	Advanced Network Timing (IEEE 1588v2 PTP)

Accessories

CRS-180	1:1 Modem Redundancy Switch (70/140 MHz)
CRS-300	1:10 Modem Redundancy Switch (Not available with Packet Processor)
CRS-280	1:10 IF Redundancy Switch (70/140 MHz)
CRS-500	1:N Modem Redundancy System (For use with Packet Processor Only)
CRS-282XXX	1:10 IF Redundancy Switch (For use with CRS-500)

Environmental And Physical

Temperature	Operating: 0 to 50°C (32 to 122°F)
	Storage: -25 to 85°C (-13 to 185°F)
Power Supply	100 – 240 VAC, +6%/-10%, 50/60 Hz, auto sensing -24 VDC (HW option) -48 VDC (HW option)
Power Consumption	48 W (typical with TPC/LDPC Codec and Carrier-in-Carrier module installed), 55 W (max.) 60 W (typical with TPC/LDPC Codec, Packet Processor and Carrier-in-Carrier module installed), 67 W max.
Dimensions (1RU) (height x width x depth)	1.75” x 19.0” x 17.65” (4.4 x 48 x 44.8 cm) approximate
Weight	10.8 lbs (4.9 kg) maximum, with all option modules installed
CE Mark	EN 301 489-1 (ERM) EN55022 (Emissions) EN55024 (Immunity) EN 61000-3-2 EN 61000-3-3 EN60950 (Safety)
FCC	FCC Part 15, Subpart B

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